Economic Efficiency in Rain-fed Farming Sector Sinnar State – Sudan

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ABSTRACT

The main objective of this study was to estimate the efficiency of resource use and to determine the optimum crop mix that would maximize the farmer returns in the rain-fed sector in Sinnar, State, Sudan. The study depended mainly on primary data that was collected by field survey. A multi-stage stratified random sample technique was used for classifying the farmers and assist in determining the sample size. A total of 173 households was chosen (104 households representing the traditional farmers and 69 households representing the semi-mechanized farmers). Data was collected through personal interviewing the selected farmers about all their farming aspects related to farming season 2011/12 using a structured questionnaire. Linear programming technique was used for analyzing the parameters of the study. The entire was firstly classified into two categories: Traditional farmers and semi-mechanized farmers, and secondly the semi-mechanized farmers were further classified into three categories based on farm size; namely small farmers with farm size of less than 500 hundred hectares, medium farms with farm size of 500 to 1000 hectares, and large farms with farm size greater than 1000 hectares. The technical efficiency of resource use indicated that the resource in both sectors for the production of all cultivated crops was not used efficiently. The results revealed that operating capital in the traditional sector was underutilized and labor and seeds were over-utilized. In the semi-mechanized sector operating capital and herbicides were underutilized, while labor and seeds were over utilized. The farmers basic plans showed that the traditional farmers cultivated a combination of sorghum, sesame, pearl millet, cowpea and groundnut, while the semi-mechanized farmers cultivated a combination of sorghum, sesame, pearl millet, and sunflower. The allocative efficiency analysis has revealed that the optimum cropping pattern for the traditional farmers is by cultivating sorghum and cowpea. The optimum cropping pattern for the semi-mechanized farms is by cultivating: only millet for the small farms, sesame and sunflower for the medium farms and sorghum and sunflower for the large farms. This optimum cropping pattern has increased the income of farmers by 43%, 31.3%, 24.7%, and 24.2 for the traditional farmers, semi-mechanized farmers, semi-mechanized large farmers, and semi-mechanized small farmers, respectively. The study suggested that the government is facilitate timely provision of necessary financial resources to farmers for improving the

efficiency of resource use. The Agricultural Extension Department is to educate the farmers about the optimum use of inputs.

INTRODUCTION

According to Stephen, J, etal, 2004 the inefficiency in use of resources and allocation of resources constitute a major problem due to increased food demand. The continuous increase of production inputs has negatively affected the optimum use of these resources. Many studies were carried out to estimate the level of efficiency in using the resources for producing the crops and to propose the required adjustments. Khalid H. A. Siddig and Babiker I. Babiker, 2012 have argued that the overall technical efficiency of Sudanese agriculture is low especially in the traditional sector that provides staple food for the majority of the subsistence farmers and other domestic consumers besides its contribution to the export sector. Mohamed *et al.* (2008) have estimated the technical efficiency of producing sorghum in western Sudan. Their results showed that the mean technical efficiency of sorghum production is 0.65, which is very close to the technical efficiency of 0.67 estimated for Sudan by Trueblood and Coggins, (2001).

Siddig, (2009) has stated that the agricultural production in Sudan and particularly in the traditional sector is technically less efficient. He proposed an introduction of advanced technologies in the agricultural practices, improved seeds, and improved extension services could enhance the sector's performance, and hence the people's livelihood. The objective of this study is to estimate the efficiency of resource use in sorghum production in the rain-fed agriculture in Sinnar state in Sudan. To achieve this objective two models were formulated to measure the selected parameters.

MATERIALS AND METHODS

The field survey has been conducted in Sinnar state. Sinnar state is located between longitudes 32 ^{o} 28" and 35 ^{o} 45" E and latitudes 12 ^{o} 05" and 14 ^{o} 07" N (Hayfa, 2001). The selection of Sinnar state was based on the importance of the state in terms of vast areas for rain-fed sector and large number of farmers involved in the rain-fed agriculture. The study is primarily depended on primary data that collected from a sample of (104) rain-fed farmers during the farming season 2012/12 using structured questionnaires about all aspects of their farming during the particular season.

Okorji and Obiechina, 1985 have stated that inefficiency in the use of resources constitutes a major attention for increasing food production in the rain-fed sector. Efficiency in use of resource is an important aspect for increasing the food production which is also associated with the management of the farmers who employ these resources in production. Furthermore, efficiency in the use of available resources is a major pivot for a profitable farm enterprise. Therefore, inefficiency in the use of resources, wrong choice of enterprise combination and cropping systems constitute the major constraints to increased food production.

The objective of the rain-fed traditional farmers is to produce satisfactory food for their families and for domestic markets and external markets in case of semi-mechanized farmers. Land, labour, operating capital, other inputs such as seeds, herbicides are the major inputs for producing sorghum in the rain-fed agriculture.

Structure of the Linear Programming (LP) models:

1. Resource use efficiency model variables:

Regression Model was used to examine input-output relationship and the implicit form of the model is given by: Y=f (X1, X2, X3, X4, X5; e)………(1)

Linear log forms of the production function were fitted to the data. The log function gave the best fit and was chosen as the lead equation on the basis of the number of significant variables, magnitude of the R^2, F statistic, standard error and the signs of coefficients. The explicit form of the lead equation is given as:

lnY = lnb0 + b1lnX1 + b2lnX2 +b3lnX3–b4lnX4 + b5lnX5 + b6lnX6 + b7lnX7 + b8lnX8 +e……….. (2)

where,

Y= Output in kilogram/tone per hectare

X1= herbicides, liter per hectare

X2= seeds, kilogram/ hectare

X3 = Operating capital, pounds per hectare

X4 = Labor, man-days per hectare

X5 = Farm size in hectares

b1-b5= Regression coefficients

e = Random error term

Efficiency of resource use was determined by the ratio of marginal value product (MVP) to marginal factor cost (MFC) of inputs based on the estimated regression coefficients. Rahman and Lawal (2003) and Iheanacho *et al.* (2000) have stated that efficiency of resource, r, is given as:

$r = MVP \div MFC$ .... (3)

The rule indicates that when $r = 1$, there is efficient use of a resource; $r > 1$ indicates underutilization of a resource; while $r < 1$ shows over utilization of a resource. The values of MVP and MFC were estimated as follows:

$MVP = MPP. P_y$

$MFC = P_{xi}$

where:

r = Efficiency ratio

MPP = Marginal physical product

MFC = Marginal factor cost, Pxi (unit price of input Xi)

Y = Arithmetic mean value of output

Xi = Arithmetic mean value of input considered

Py = Unit price of output.

Mijindadi, (1980) has stated that the relative percentage change in MVP of each resource required so as to obtain optimal resource allocation that is, r = 1 or MVP = MFC, was estimated using the following equation: $D = (1 – MFC/MVP) \times 100$.

2. Optimum crop combination Model variables:

The general algebraic formulation of linear programming in this study as follows:

Maximize $Z = \sum i{=}i \ C_j X_j$ ($j = 1, 2, 3 \ldots\ldots\ldots..,n$)

Subject to: $\sum i{=}1 a_{ij} X_i <= b_i \ x_j \ 0$ ($I=1,2,3 \ldots\ldots\ldots\ldots.,m$)

where:-

Z = net farm income (SDG)

i = level of resources

j = level of activity

Cj = net return per unit to jth activity

Xj = the level of the jth farm activity including all crops i.e. sorghum, millet, sesame, & sunflower in the mechanized sector and sorghum, millet, sesame, cowpea, and groundnut for traditional sector.

n = number of activities in the model

aij = the quantity of the resource used by the jth activity i.e. input/output coefficients.

bi = vector of resources availability (land, labor, capital, etc …)

where:

Labor = total man-days provided by the farmer.

Land = Total land owned by the farmer for cultivation.

Capital = cash in hand plus advances as loans or credits (for inputs).

RESULTS AND DISCUSSIONS

Table-1: Level of efficiency of resource use for different crops/ traditional sub-sector:

	Cultivated crops				
Resource	**Sorghum**	**Sesame**	**Millet**	**Cowpea**	**Groundnut**
Seeds	Over utilized	Underutilized	Underutilized	Efficient	Efficient
Capital	Underutilized	Underutilized	Underutilized	Underutilized	Underutilized
Labor	Over utilized	Over utilized	Over utilized	Over utilized	Over utilized
Area	Underutilized	Underutilized	Underutilized	Underutilized	Underutilized
Overall	67%	61%	67%	78%	79%

The results presented in table-1 are indicating that the marginal contributions of production resources in terms of physical and value products. Increasing the expenditure on labour and operating capital each of them by 1% would lead to decreasing the returns of sorghum by 0.28% and 0.53% respectively; whereas increasing the expenditure on area and seeds each of them by 1% would lead to decreasing the returns of sorghum by 0.12% and 0.11% respectively.

Table-2: Level of efficiency of resource use for different crops/ Semi-mechanized sub-sector:

	Cultivated crops			
Resource	**Sorghum**	**Sesame**	**Millet**	**Sunflower**
Herbicides	Underutilized	Not used	Not used	Not used
Seeds	Over utilized	Over utilized	Over utilized	Over utilized
Capital	Underutilized	Over utilized	Over utilized	Underutilized
Labor	Over utilized	Over utilized	Over utilized	Underutilized
Area	Over utilized	Underutilized	Underutilized	Underutilized
Overall	**63%**	**67%**	**69%**	**66%**

2.1 Resource productivity:

The results in table 2 are indicating that the marginal contributions of production resources in terms of physical and value products. Increasing the expenditure on the herbicides and operating capital each of them by 1% would lead to decreasing the returns of sorghum by 0.216% and 0.609% respectively. On the other hand increasing the expenditure on labor by 1% would lead to decreasing the returns of sorghum by 0.19%.

In summary the positive coefficient implies that an increase in the quantity of input will result into increase in output; and for the significant factor inputs, it means these are the major determinants of output. The negative sign of family labor suggests an inverse relationship with output. For the semi-mechanized farmers it would be necessary to increase the quantities of herbicides and operating capital and at the same time to decrease the quantities of seeds and labour. But with the traditional farmers would be necessary to use more of area operating capital quantities and less of seeds and labour quantities.

2.2 The optimal crop combination

Table (3): The optimal crop combination

	Traditional sector	**Semi-mechanized farming**

			Small Farms size<500 Ha		Medium Farms size>500 <1000Ha		Large Farms size =>1000Ha		Partially adopted technology	
	Act	**Opti**	**Act**	**Opti**	**Act**	**Opti**	**Act**	**Opti**	**Act**	**Opti**
A: Cropping pattern:										
Sorghum	7.6	7.17	210.5	0.0	679	0.0	1760	2695	439.2	0.0
Sesame	4.0	0.0	77.3	0.0	224	0.0	330	0.0	129.34	147.2
Millet	2.7	0.0	65.7	368.9	166.3	219.3	448	0.0	116.43	0.0
Cowpea	0.4	9.81	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
G.nuts	0.24	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sunflower	0.0	0.0	144.6	0.0	73.5	914.7	630	222.31	287	126.7

B: Resource use:

	Traditional sector		Semi-mechanized sector							
			Small Farms size<500 Ha		**Medium Farms size>500 <1000Ha**		**Large Farms size =>1000Ha**		**Partially used technology**	
	Act	**Opti**	**Act**	**Opti**	**Act**	**Opti**	**Act**	**Opti**	**Act**	**Opti**
Land	18.7	16.9	798.1	368.9	2234	1134.1	3168	2917	711.6	274
Labor	331	331	4451	3357.8	10408	9576.5	22089	21676	7074	4433
Capital	5864	6848	112727	110727	384629	384629	722790	722790	362624	135917
Seeds	120	120	3030.8	1143.9	24975	3515	29342	21326	848.5	849
Fuel	57.9	52.6	1585	2804.3	7497.5	7078	5414	9043.7	2622	2622

Act: Actual **Opti: Optimal**

2.3 Sensitivity Analysis scenarios:

For the objective of the optimum cropping pattern the research has tested the following scenarios:

1. Increasing the farm land by 25 percent
2. Increasing the operating capital by 25 percent .

3. Decreasing the exchange rate by 25 percent.
4. Increasing the productivity by 25%.

Scenarios test has concluded the following:

Table(4): Sensitivity Analysis Results

C: Returns:										
	Traditional sector		Semi-mechanized sector							
			Small Farms size<500 Ha		**Medium Farms size>500 <1000Ha**		**Large Farms size =>1000Ha**		**Partially used technology**	
	Act	**Opti**	**Act**	**Opti**	**Act**	**Opti**	**Act**	**Opti**	**Act**	**Opti**
Objective function value	9277	13274	145482	180732	560971	738841	1154820	1440327	109214	153149
Value %		43.1		24.2		31.3		24.7		40.2
Increasing productivity Value %.		46.8		40.17		34.38		26.94		40.23
Increasing operating capital value %.		48.85		55.29		50.1		41.6		56.3

Act: Actual, Opti: Optimal

3.Conclusions and Recommendations:

The study concludes the following:

1. Resources are not used efficiently in both sub-sectors of rain-fed agriculture.
2. The current crops combination is not optimal in both sub-sectors.

The study recommends the following:

1. Farmers have to be enlightened/ educated about the:

a. Efficient way of resource use.

b. Optimal crop combination suitable for each sub-sector.

2. Facilitation of timely provision of necessary financial resources and necessary inputs to farmers.

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